Early Childhood Health Shocks and Adult Wellbeing: Evidence from Wartime Britain

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December 2016

**Abstract:** A growing literature argues that early environments affecting childhood health may influence significantly later-life health and financial wellbeing. We present new evidence on the relationship between child health and later-life outcomes using variation in infant mortality in England and Wales at the onset of World War II. Using data from the British Household Panel Survey, we exploit the variation in infant mortality across birth cohorts and region to estimate the associations between health shocks during childhood and adult outcomes such as disability and health status. Our findings suggest that higher infant mortality is significantly associated with higher likelihood of disability, a lower probability of employment, a lower probability of having any earned income, less earned income, and the presence of serious health conditions.

Keywords: Fetal origins; World War II; health capital

**Introduction**

A growing literature argues that early environments affecting childhood health may influence significantly adult health and socioeconomic status (Almond and Currie 2011). If so, then investments in early childhood health may have particularly large returns and public policy targeted at infant and child health should be encouraged, particularly when private investment is relatively low. In addition, if childhood health does have a lasting effect, then associations between income and education, and health among adults may be overstated because child health may have influenced these outcomes.

Several studies have assessed the hypothesis that early environments have lasting effects. Some studies found a positive relationship between in-utero, or infant, health and later-life outcomes. For example, Chay et al. (2009) found that desegregation of hospitals in the southern United States that caused a reduction in black, post-neonatal mortality narrowed the black-white high school achievement gap. Other studies that find a positive relationship between infant (in-utero) health and adult outcomes include Almond (2006), Kelly (2011), Bharadwaj et al. (2013), Roseboom et al. (2001), Almond et al. (2007), Almond et al. (2012), and Almond and Mazumder (2005). However, quite a few studies have reported null findings including Brown and Thomas (2013), Cutler et al. (2007), Stanner et al. (1997), and Kannisto et al. (1997). Lastly, Bozzoli et al. (2009) found that in relatively poorer countries, worse infant health improved later-life outcomes through apparent selective mortality. In short, while the “early origins” hypothesis is often cited as fact, there is substantial heterogeneity in the research findings that warrants additional study.[[2]](#footnote-2)

We present new evidence on the relationship between child health and later-life outcomes using variation in infant mortality in England at the onset of World War II. In England between 1939 and 1941, infant mortality rose 17 percent, although the increase is even larger than this value implies because infant mortality was declining steadily during this period. The increase in infant mortality was largely driven by a marked increase in post-neonatal deaths. The sharp rise in mortality was also found for child mortality. Historical evidence indicates that the rise in infant and child mortality during this period was due to a combination of a wartime food rationing program and unusually harsh winters. From 1942 onward infant and child mortality fell back to their pre-1940 trend because of priority rationing that favored pregnant women, less harsh winters, and improvement in health services (see Figure 1).

Within England, the extent to which infant and child mortality increased varied across regions. For example, infant mortality in London changed little between 1939 and 1941 while in Northeast England it rose by nearly 27 percent. Because the negative health shock was short lived, severe, and varied within the country, it provides a natural opportunity to test the relationship between exposure to an adverse, early childhood health environment and later-life outcomes.

Using data from the British Household Panel Survey, we exploit the variation in post-neonatal mortality across birth cohorts and regions to estimate associations between post-neonatal mortality and adult outcomes such as presence of various health conditions, employment, earned income, home ownership, and disability. Our findings suggest that the increase in infant mortality in the early 1940s is associated with worse health as an adult. Specifically, a one standard deviation increase in infant mortality is associated with a 37% increase in reporting poor or very poor health; a 15% increase in reporting an arm/leg/hand problem; a 32% increase in reporting a chest/breathing problem; a 50% increase in reporting a disability; a 9% decrease in the probability of having a job; a 9% decrease in the probability of having any earned income; and a 13.5% decrease in annual real earned income.

**Background: England in the 1940s**

Since the 1930s, infant mortality in England followed a marked downward trend except for 1940 and 1941, as shown in Figure 1. In 1941, infant deaths rose to 59 for every 1,000 births compared to 50 in 1939 and 49 in 1942. The deviation from trend in 1940 and 1941 is arguably the result of the interaction of food rationing policies, World War II, and the unusually harsh winters of 1940 and 1941, each of which we discuss in turn.

The Ministry of Food was created in 1939 and was responsible for food distribution during the war. Various rationing schemes were used including direct distribution of items and allocations based on coupons and points for different foodstuffs. Food items including milk, eggs, cereals, oranges, butter, bacon, sugar, meats, and cheeses were rationed beginning in January of 1940 at the start of major wartime actions and rationing became increasingly stringent as the war went on. The daily rations provided approximately 910 calories, but little calcium and vitamins. To protect the health of women with children and expectant mothers, the National Milk Scheme was started in June of 1940 and provided additional priority allowances, which supplied an additional 540 calories and the bulk of their daily requirement of calcium and vitamins. However, initial take-up was low and the program did not witness significant uptake until 1942. The priority allowance was later credited as having “done more than any other single factor to promote the health of expectant mothers and young children during the war” (Great Britain Ministry of Health 1946, 93).

In addition to rationed food, England was under assault from German bombing campaigns that targeted the more densely populated and better developed areas of England such as London. From these areas, the government evacuated children and expectant mothers to rural areas in England (Great Britain Ministry of Health 1946, 92). The evacuation caused shortages in supplies, staff, and accommodations in destination areas that could adversely affect the quality of infant and child healthcare. By 1940, England had developed day nurseries for displaced children and children of parents engaged in the war effort (Great Britain Ministry of Health 1946, 98). Initially, staying in the day nurseries was associated with the transmission of infectious disease given close confinement of children, but by 1942 the quality of the nurseries as well as staffing and supplies improved decreasing incidence of disease (Great Britain Ministry of Health 1946, 99).

Furthermore, the 1939-40 and 1940-41 winters produced extremely low temperatures, extensive frosts, and large snows. The meteorological record from the period described January 1940 as “exceptionally cold; intense frost; considerable snow in the latter half of the month”; January 1941 was described as “cold, with frequent snow” (“Monthly Weather Reports 1940s” 2016). The inclement weather of the period was not uniform across regions, however, as England has surprisingly diverse microclimates that exacerbate or buffer general weather patterns (see Appendix Table 1 and http://www.metoffice.gov.uk/media/pdf/n/9/Fact\_sheet\_No.\_14.pdf).

Table 1 displays infant mortality rates by cause between 1939 and 1944. The noteworthy increases occurred in 1940 and 1941 and are concentrated among whooping cough, measles, bronchitis, and pneumonia. All these illnesses are conditions that could have been plausibly affected by inadequate nutrition, inclement weather, and general wartime dislocation. Take, for example, the striking increase in measles in 1940 and 1941. Measles is highly contagious and measles severity and mortality is caused by deficiency of vitamin A (D’Souza and D’Souza 2002). Milk and eggs are foods that are high in vitamin A and those were among the rationed food items that were particularly scarce in the early war years. In addition, the crowding of children into day nurseries would have facilitated the transmission of measles because of its infectious nature. Similarly, hard winters combined with a lack of fuel products to heat homes (from the ration) likely contributed to many of the pneumonia and bronchitis deaths and the observed increase in infant mortality over this period (Griffiths and Brock 2003).

Figure 2 displays the overall trend in neonatal and post-neonatal mortality in England and Wales from the period. Note that while overall neonatal mortality increases somewhat, the significant deviation from trend occurs for post-neonatal mortality. To more closely focus on the post-neonatal period, Appendix Figure 1 displays child mortality for children aged 1-2 and those aged 3-5. Both groups experienced significant percentage increases in mortality in 1940 and 1941. Given this evidence, our analysis pays close attention to the relevant birth cohort in our examination of later life outcomes.

Notably, we also observe substantial variation in the magnitude of infant deaths within England across regions. Generally, areas farthest from London experienced the greatest rise in infant mortality. In Figure 3 we present the difference in infant mortality between observed value and a predicted linear trend by region. A value of zero indicates that infant mortality in a region is perfectly on trend. In 1941, there is a clear upward divergence from trend with regions farthest from Greater London experiencing the largest increases.

The evidence from rationing and harsh winters is consistent with areas farther from London experiencing a greater increase in infant mortality (see Appendix Table 1). More remote areas likely had fewer resources and fewer rationed goods; and historical weather information suggests that the winters in the north of England were somewhat harsher than in the south, which also partly explains the within-country variation.[[3]](#footnote-3) Moreover, the predominately rural areas where shelters were built to house expectant mothers were also away from London, which would additionally explain part of the pattern in infant mortality.

To summarize, Figures 1-3 and Table 1 document the circumstances surrounding the significant spike in post-neonatal and early childhood mortality. The combination of food shortages, harsh weather, and disruption in children’s healthcare resulted in greater incidence of infectious respiratory disease for young children in 1940 and 1941. Additionally, the incidence differed substantially by region within England. The variation in child health across both time and region, as measured by infant mortality, represents our measure of the exposure to adverse health shocks.

**Data**

Data for the analysis comes from the British Household Panel Survey (BHPS) and the Great Britain Historical Database. The BHPS is a longitudinal survey of approximately 5,500 households in Britain from 1991 to 2009. The survey is well suited for our study because respondents are asked their year and place of birth, which we match with the Great Britain Historical Database to determine exposure to the health shock as an infant. The Great Britain Historical Database contains information on infant deaths and births as well as population by location and year. From this, we calculate infant mortality and birth rates by region and year.[[4]](#footnote-4) While county-level information is available in both data sets, a significant number of the counties of birth in the BHPS are not listed in the historical database, and therefore, we aggregate infant mortality to the region level; there are ten regions in total—nine in Great Britain plus Wales.

Survey respondents in the BHPS answer questions about their health including self-reported health status, presence of health problems, and disability status in addition to information about employment, income, and home ownership. For self-reported health status, individuals are asked, “Please think back over the last 12 months about how your health has been. Compared to people of your own age, would you say that your health has on the whole been” and they may check excellent, good, fair, poor, or very poor from which we define two indicators: an indicator for good or excellent health and an indicator for poor or very poor health. For the presence of health problems, individuals are asked “Do you have any of the health problems or disabilities listed on this card?” which include thirteen conditions including problems with arms or legs, problems with chest or breathing, problems with heart or blood pressure, difficulty seeing, difficulty hearing, skin conditions, stomach/liver/kidney, diabetes, nerves/anxiety/depression, alcohol/drugs, epilepsy, migraine/chronic headache, or other. Respondents could check any conditions that apply and our measure of any self-reported health problems is an indicator that equals one for those who suffer from at least one of the aforementioned conditions. We also examine the top three most prevalent conditions individually.[[5]](#footnote-5) Our measure of disability status comes from the question “Can I check, are you registered as a disabled person, either with Social Services or with a green card?” Those who check yes are defined as disabled. Our measure of home ownership comes from a question that asks individuals if they own a home or rent a home. We define an indicator for home ownership equal to one if the individual responds that they own their home outright or with a mortgage and zero otherwise. We measure employment using a dichotomous measure that equals one if the respondent did any paid work in the previous week and zero otherwise. Finally, respondents report annual income from labor and we construct two variables with respect to this measure—whether a person has any earned income and the amount of earned income.

To construct our sample, we begin by limiting the data to those born between 1940 and 1964 which leaves 98,412 person-by-wave observations. We exclude data prior to 1940 to identify birth cohorts that are affected by the spike in infant mortality. As we showed earlier, child mortality also increased in 1941 and thus, children born earlier than 1940 were affected by the wartime problems. In most analyses, we exclude these cohorts to isolate the effect of the war on infants born in 1940 and 1941 that were the most affected. However, we also report analyses that include earlier birth cohorts, and as expected, including these cohorts attenuates the effect of infant mortality on adult outcomes. We discuss this in more detail below. We also show estimates using different ending year birth cohorts than 1964: specifically, 1950 and 1960. From the 98,412 persons observed after the primary sample selection criteria were applied, we drop 9,536 observations that are missing information for place of birth and another 21,941 born outside of England or Wales (no data are available on infant mortality in Scotland). Last, to maintain a consistent sample across all our regressions, we drop 2,710 observations that have missing information for different outcome variables. Our final sample consists of 64,225 person-by-wave observations.

Table 2 reports descriptive statistics. On average, the sample is 46.6 years of age, although there is significant variation in age indicated by a standard deviation of 8.75 years. Slightly more of the sample is female (53%), which is consistent with longer life expectancy of females vis-à-vis males. In terms of outcomes approximately 59% report a health problem, although only 10% report being in poor or very poor health. The apparent discrepancy between the proportion being in poor health and the proportion with a health problem likely reflects the self-reported nature of the questions and the fact that many respondents report a health problem that is relatively minor.

**Statistical Methods**

The hypothesis underlying our analysis is that exposure to a health shock while a child (infant) may affect adult outcomes in two primary ways. The first channel is often referred to as “scarring” (Elo and Preston 1992). The scarring channel suggests that exposure to a negative health shock may weaken the entire birth cohort so that later-life outcomes for those exposed may be worse. For example, if exposure to food rationing and harsh winters merely weakened the entire cohort, we would expect to observe worse later-life outcomes for those born during this period. A second channel is often referred to as “culling.” The culling channel suggests that during exposure to an adverse health event the weakest children may die leaving those who survive a stronger group of children in observed and unobserved dimensions. If culling is the predominant channel, then we may expect improved later life outcomes from the birth cohort exposed to the shock. Which channel dominates is an empirical question. There may also be behavioral responses to the health shock in childhood. Parents may respond by investing in affected children and, as we discuss below, fertility may be affected by the health shock. Parental responses and their influence are additional considerations relevant to the interpretation of estimates of the association between child health and adult outcomes. Such behavioral responses may reinforce or offset the scarring and culling effects.

**Basic Model**

To estimate the later-life effects of early childhood health shocks, we specify the following regression model:

(1)

*=* (individuals)

(Regions)

(Birth year)

(Birth month)

(Survey Age)

where adult outcome for individual born in region in birth year and month *m* and surveyed at time is a function of the infant mortality rate (per one thousand live births) in their region and year of birth , observable individual characteristics at the time of survey including current place of residence and sex, a region of birth fixed effect , a birth cohort fixed effect , a birth month effect , a survey age fixed effect , and an error term *.* The adult outcomes we consider are self-reported health status, incidence of health problems, disability status, labor force participation, real annual labor income, and home ownership.[[6]](#footnote-6) As we already discussed, treatment, or exposure, is measured by the infant mortality rate in region *j* and birth year *k*.

The region fixed effect () accounts for unobserved differences between the regions including resources available, local development, and any other fixed differences across regions related to both infant mortality and later-life outcomes. As Figure 3 showed, each region experienced different exposure to infant mortality, and by including the fixed effect, we compare only within region. The birth cohort fixed effect () accounts for differences by year of birth common to all individuals in England such as changing medical technology, which captures the downward trend in infant mortality experienced during this time. The survey age fixed effect () accounts for any differences in age at the time of the survey (and any survey year effects because birth year plus age equals survey year). The identifying assumption of our approach is that conditional on region, age, and birth year fixed effects, variation in infant mortality is largely driven by exogenous factors associated with the war such as food rationing and adverse weather conditions. In some specifications, we include region-specific linear time trends.[[7]](#footnote-7)

To estimate equation (1), we use a linear probability model for dichotomous outcomes, but marginal effects are similar when using a logit model. In the case of earned income, we use a generalized linear model (GLM) specification with a log link function and a gamma distribution assumption. The effect of infant mortality as embodied in the coefficient *β1* represents the consequences of an adverse health shock prior to age 2 because by 1942 the infant mortality rate returns to its pre-war trend and we are restricting the sample to those born in 1940 or after. In all specifications, we standardize infant mortality to have an overall mean of 0 and standard deviation of 1. The standard deviation of infant mortality is 12.7, roughly the size of the mortality shock in 1940/41.

**Considering Birth Rates**

One issue that must be considered is the potential response of births to infant health shocks. For example, parents may try to replace children lost to illness (Ben-Porath 1976). Wartime in the UK brought considerable changes in birth rates. Total births in London fell along with the population, but rebounded beginning in 1942 (available in Appendix Figure 2). A similar pattern is evident from the regions outside London (Appendix Figure 3). Also, note that London makes up a relatively small fraction (15%) of total births. We also document birth rates for the entire country (Appendix Figure 4), which indicates that the birth rate started increasing beginning in 1942, eventually peaking in the immediate post-war years. Birth rates from 1935-41 were stable at around 15 per 1,000 total population, but in 1942 birth rates increased to 17 per 1,000 total population. From 1942 until well after the end of the war, birth rates stay at or above this elevated level with some noticeable decline after 1947.

The increase in birth rates in 1942 is suggestive of a parental response to the negative health shock that may vary at the region-by-time level and would not be accounted for by any of the fixed effects in the regression specification. In short, the fertility response may have altered later life outcomes because of differences in family size (spacing) by birth cohort and region. Therefore, we estimate some models with birth rates to assess whether estimates of the association between infant mortality and later life outcomes is sensitive to the inclusion of birth rates.

**Measurement of Exposure**

Our measure of exposure, or treatment, is the infant mortality in the region and year, which is derived from administrative data. Given the wartime relocations, there is a question as to whether births and deaths were recorded consistently with respect to place of residence or place of occurrence. The administrative data are quite clear that deaths were recorded based on place of occurrence. However, it is possible that births might have been recorded at place of permanent residence if relocation occurred soon after birth, but there were great efforts to relocate pregnant women. For example, in 1939, 13,900 pregnant women were relocated out of greater London (Johnson 1985). Consistent with this, births in London fell by roughly 20,000 between 1939 and 1941 (Appendix Figure 2). Therefore, it is likely that most births were recorded in the place of occurrence and thus the extent of any misreporting of births would appear to be small.

A second concern is measuring exposure for individuals that were relocated. Note that the adverse health shocks were manifest within the first year of life, as shown in Figure 2. Thus, infant mortality in the place of birth accurately reflects exposure for all those who stayed in the relocation region for several months, which is likely to be the vast majority of persons that were relocated.[[8]](#footnote-8) Exposure would be incorrectly assigned if survey respondents who had been relocated reported their birth region as their permanent residence rather than the actual region of birth. To address this concern, given that most of the relocation is associated with London, we re-estimate our regressions omitting survey respondents born in London. Our findings are largely unchanged when we omit London births.

**Results**

Table 3 presents estimates of the effect of infant mortality in the respondent’s region and year of birth on adult outcomes.[[9]](#footnote-9) In all regressions, infant mortality is standardized to have an overall mean of 0 and standard deviation of 1 and standard errors are clustered by region of birth-by-year of birth cells. The first column of Table 3 shows the baseline specification without additional person-level covariates or controls for birth rates. The second column adds person-level controls including age, sex, and current region of residence. The third column adds the birth rate in the year and region the respondent was born.

Estimates for each outcome are similar across the three columns and consistent with the presence of scarring and an adverse effect of poor child health on adult health and socioeconomic status. For instance, the effect of infant mortality on self-reported poor or very poor health in columns 1 through 3 suggest that a one standard deviation increase in infant mortality (roughly the size of the increase between 1939 and 1941) is associated with a 3.7 percentage point increase in self-reported poor or very poor health, which is a 37% increase relative to the mean. The estimate remains stable across all specifications. A summary of the effects of a one standard deviation increase in infant mortality is as follows:

* approximately a 4 percentage point (15%) increase in report of an arm/leg/hand problem;
* approximately a 3.5 percentage point (32%) increase in report of a chest/breathing problem;
* approximately a 6 percentage point (50%) increase in report of disability;
* approximately a 6.5 percentage point (9%) decrease in the probability of having a job;
* approximately a 7 percentage point (9%) decrease in the probability of having any labor income;
* and an approximately a [£](https://en.wikipedia.org/wiki/Pound_sign)2000 reduction (13.5%) in annual real labor income.

**Placebo Tests**

In order to assess whether these estimates are valid, we conducted two “placebo” analyses in which we expect to find zero effects. First, we reassign the true value of infant mortality using the value of infant mortality in a randomly selected birth region. For example, the randomization assigned all those born in East Midlands (in any year) the infant mortality rate in the South East (in the same birth year). We did this randomization 1000 times and re-estimated the model using the specification in column (3) of Table 3.[[10]](#footnote-10) The second “placebo” analysis reassigned the true value of infant mortality using the value of infant mortality in a randomly selected birth year. For example, we reassigned all persons born in 1948 the infant mortality in their region in 1942. Again, we did this randomization 1000 times and re-estimated the model.

Table 4 displays the results of these two “placebo” analyses. Column (1) of Table 4 shows the estimates from column 3 of Table 3. Columns (2) and (3) report p-values from the two placebo analyses. The p-values are calculated as the proportion of estimates (out of 1000) that are larger in absolute value than the estimate in column (1). So the p-value of 0.125 in row (1) and column (2) of Table 4 indicates that 125 out of the 1000 estimates from the randomization exercise that reassigned regions were larger than the actual estimate. This finding suggests that the actual estimate is not “unusual” and is unlikely to be a true effect. Consistent with this result is the fact that the estimate in row (1) and column (1) of the effect of infant mortality on excellent health is small (<3.5%) and not statistically significant. For every outcome, the results of the two placebo analyses are consistent with the actual results reported in column (1) of Table 4. When the actual estimate is relatively large and statistically significant, the corresponding p-value from the randomization “placebo” tests are small. These results provide strong evidence that the estimates in Table 3 are reliable and likely to reflect true effects of the effect of early childhood health shocks.

**Sensitivity Analyses**

*Altering the Birth Cohorts Examined*. As noted earlier, we intentionally limited the sample to those born in 1940 or later because the historical evidence suggested that the effects of the war were most pronounced among very young children. Cohorts born before 1940 were also exposed/treated. Thus, including children born in prior years and who were still in early childhood in early 1940s at the time of the infant mortality spike should attenuate estimates of the effect of infant mortality obtained using the sample restricted to birth cohorts of 1940 and later. We assess this hypothesis by re-estimating the regression model with a sample that includes these earlier cohorts. We also explore whether estimates are sensitive to using different ending birth cohorts instead of 1964, specifically, 1950 and 1960.

Table 5 presents estimates from models that use different samples. For comparison, Column 1 replicates column 3 of Table 3. Column 2 presents estimates from models that use cohorts born between 1936 and 1964. Those born in 1936 were already age 5 in 1940. Columns 3 and 4 report estimates from samples that include individuals born between 1940 and 1950, and 1940 and 1960.

Comparing the estimates in column 2 of Table 5 with the corresponding estimates in Table 3 (redisplayed in column 1 of Table 5), indicate that, as expected, estimates in Table 5 have the same sign as those in Table 3, but are almost always smaller. For example, the estimate of the effect of infant mortality on poor health is approximately 25% smaller than the analogous estimate in Table 3, and the estimates of the effect of infant mortality on disability in Table 5 is approximately 15% smaller than the corresponding estimate in Table 3. These results provide further support that we have identified a true effect of infant and child mortality.

Estimates in columns 3 and 4 are also generally consistent with those in Table 3. There is less evidence of an effect of infant mortality on self-reported poor health and whether a person reported an arm/leg/hand problem, but other estimates in columns 3 and 4 are very similar to those in column 1. In sum, changing the ending period of birth cohorts has relatively little effect on the estimates.

*Omitting London.* Because London played a key role in the war as both a target of bombing campaigns and as a source of population relocation, as noted previously, we are concerned about potential measurement error in infant mortality. We address this by re-estimating all models omitting people who reported being born in London (region). Table 6 reports these estimates. A comparison between estimates in Table 6 and Table 3 indicates that they are very similar, suggesting measurement error introduced by dislocation does not introduce bias.

*Using Only the 1940 and 1941 Variation in Infant Mortality.* To this point, our analyses have used variation in infant mortality by region and birth year. The inclusion of region and birth year fixed effects controls for most of the variation in infant mortality. For example, a regression of infant mortality on region and birth year fixed-effects has an R-square of approximately 0.96—implying that 96% of the variation in infant mortality is explained by these fixed effects alone. This is consistent with the evidence in Figures 1-3, which shows that other than 1940 and 1941, infant mortality follows a very predicable trend during the period. Thus, the only meaningful variation in infant mortality is from the deviations from trend in 1940 and 1941.

Nevertheless, it may be argued that use of all the variation in infant mortality may induce bias from endogenous changes in infant mortality unrelated to the wartime conditions that we have argued are largely exogenous. To assess this possibility, we re-estimated the models of Table 3 using an alternative measure of treatment. Specifically, we set infant mortality to zero in all years except 1940 and 1941, and used this measure of treatment in the regression. Note that this alternative measure changes the scaling of the measure of treatment and will affect the magnitudes of the estimates, which will be an important point to remember when comparing estimates to those in Table 3.

Table 7 reports estimates obtained using this alternative measure of treatment. Most of the estimates in Table 7 are consistent with those in Table 3 and similar in sign, magnitude and statistical significance. There are two exceptions: poor health and having an arm/leg problem. For these two outcomes, the estimates in Table 7 are smaller in magnitude and not statistically significant. Overall, estimates in Table 7 support previous estimates.

*Adding Region-specific Trends.* Lastly, to assess whether there are omitted variables, we re-estimated the regression models with region-specific, birth-year linear time trends to control for potentially unmeasured confounding factors that vary by region and birth year. However, the value of this analysis is diminished by the fact that after including region-specific time trends there is little independent variation in infant mortality. Region, age, year and region-specific birth-year trends explain 99% of the variation in the infant mortality. Therefore, the ability to identify reliably an effect of infant mortality is low, which makes the value of the analysis suspect. Standard errors of the estimates are approximately 50%-100% larger when these additional controls are included in the regression model.

We present the estimates in Appendix Table 2. Column 1 repeats estimates from column 3 in Table 3. Column 2 shows results with the inclusion of region-specific birth-year trends. The estimates are generally similar, but there are three notable differences. Estimates of the effect of infant mortality on presence of an arm/leg/hand problem, whether a person has a job, and whether a person has any earned income in column 2 differ from the corresponding estimates in column 1, although the large standard errors suggest that the estimates are not significantly different. For example, the confidence interval for the estimate of the effect of infant mortality on presence of an arm/hand/leg condition in column 2 includes the estimate in column 1. The same applies to estimates pertaining to whether a person has a job. In fact, for every estimate but one (any labor income) in column 2, the confidence interval contains the estimate in column 1.

**Conclusion**

The marked increase in infant mortality in England and Wales during WWII represents a severe infant and child health shock. As other research has suggested, such adverse health shocks early in life may have long lasting effects. In this paper, we add to that literature by examining how the spike in infant mortality in Great Britain at the start of WWII affected adult outcomes. Historical evidence suggests that the sharp rise in infant mortality in England in 1940 and 1941 was largely driven by a combination of a wartime food rationing program, unusually harsh winters, and dislocation of families and health services due to the war. Moreover, the extent of the adverse health shocks varied considerably across regions within England. It is this, plausibly exogenous, variation in infant health that we leverage to identify our estimates.

We find that the wartime spike in infant mortality had a negative effect on later-life outcomes. The results are consequential in magnitude. We find that a one standard deviation increase in the region-specific infant mortality rate (roughly the size of the increase between 1939 and 1941) was associated with a 50% increase in the rate of self-reported disability and a 10% decrease in the probability of having a job and any earned income. In absolute terms, these two estimates are approximately equal and suggest plausibly that disability causes a person to drop out of employment. We also report consistent evidence that a one standard deviation in infant mortality was associated with a 33% increase in the probability of having a chest/breathing problem. We also find that the wartime increase in infant mortality was associated with an increase in self-reported poor health and the presence of an arm/leg/hand problem, but these results were less consistent (see Tables 5 and 7).

Our results are relevant for a contemporary audience as unfortunately wartime depredations are still common in various parts of the world. Our results suggest that the long-term consequences of such exposure are manifold even in a context of general peace and prosperity such as that which reigned in England after the war. Additionally, our work adds to the small but growing literature documenting the life-long consequence of early-life exposures to health shocks of increasingly varied form.

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| **Fig. 1** Infant Mortality (Per 1,000 Births) in England – 1931 to 1964  *Source:* Authors calculations from table “mort\_lgd” in the database of “Birth & Death Statistics for Local Government Districts from 1921-1974.”  *Notes:* In the figure we plot average infant mortality by year for those born in England between 1931 to 1964. |



**Year**

**Fig. 2** Infant Mortality by Age, Deaths per 1,000 related live births, England and Wales

*Source:* Authors calculations based on data from On the State of the Public Health During the Six Years of War

*Notes:* This figure plots neonatal (0 to 1 month) and post-neonatal mortality (1 to 12 months) mortality in England and Wales. The figure illustrates that the aggregate spike observed in Figure 1 was driven largely by an increase in post-neonatal mortality.

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| **Fig. 3** Deviations in Infant Mortality (Per 1,000 Births) from within-Region Trend – 1930 to 1964  *Source:* Authors calculations from table “mort\_lgd” in the database of “Birth & Death Statistics for Local Government Districts from 1921-1974.”  *Notes:* This figure plots deviations from a region-specific linear trend in infant mortality from 1930 to 1950. It illustrates that there is substantial variation within the country in the extent to which infant mortality increased. |
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| **Table 1** Year-to-year Percent Change in Infant Mortality by Cause of Death | | | | | | | |
| *All infants under 1 year* | | Level in ‘39 | % ‘39 to ‘40 | % ’40 to ‘41 | %’41 to ‘42 | %’42 to ‘43 | %’43 to ‘44 |
|  | Bronchitis and pneumonia | 8.9 | 43 | 08 | -33 | 11 | -17 |
|  | Whooping Cough | 1.1 | -45 | 250 | -62 | 13 | 11 |
|  | Measles | 0.1 | 300 | 50 | -67 | 100 | -75 |
|  | Tuberculosis diseases | 0.5 | 20 | 17 | -29 | 00 | -20 |
|  | Convulsions | 1.2 | 00 | 08 | -23 | -20 | -25 |
|  | Enteritis and diarrhea | 4.3 | 02 | 09 | 08 | -06 | -02 |
|  | Congenital malformations | 6.1 | 08 | 00 | -02 | -09 | -07 |
|  | Premature birth | 14.9 | -03 | 02 | -07 | -07 | -08 |
|  | Injury at birth | 2.7 | 00 | -04 | 00 | -08 | 00 |
|  | Asphyxia, atelectasis | 2.1 | 10 | -04 | -09 | -10 | 11 |
|  | Congenital debility | 1.7 | 24 | 00 | -24 | -19 | -15 |
|  | Hemolytic disease | 0.5 | 00 | 00 | 20 | 00 | 00 |
|  | Other causes | 6.5 | 28 | -02 | -17 | -01 | 00 |
| *Source:* Authors calculations based on data from On the State of the Public Health During the Six Years of War  *Notes:* We present year-to-year changes in infant mortality by major causes of death. The column “Level in ‘39” presents the level of mortality attributable to each cause. The remaining columns are yearly percent change. For example, in 1939 8.9 deaths per 1,000 births were due to bronchitis and pneumonia. From 1939 to 1940, bronchitis and pneumonia deaths grew by 43% (i.e. to a level of 12.7 deaths per 1,000 births). | | | | | | | |

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| **Table 2** Sample Characteristics | | |
|  | Mean | Std. Dev. |
| Infant Mortality per 1,000 Live Births | 32.10 | 12.72 |
| Birth Rate per 1,000 total population | 17.19 | 1.81 |
| Good or Excellent Self-Reported Health | 0.72 | 0.45 |
| Poor or Very Poor Health | 0.10 | 0.30 |
| Has Recent Inpatient Visits | 0.09 | 0.28 |
| Has Reported Health Problems | 0.59 | 0.49 |
| Has Arm/Leg/Hand Problem | 0.27 | 0.45 |
| Has Chest/Breathing Problem | 0.11 | 0.32 |
| Has Heart/BP Problem | 0.13 | 0.34 |
| Disabled | 0.12 | 0.32 |
| Has a Job | 0.71 | 0.45 |
| Has Any Annual Labor Income | 0.78 | 0.41 |
| Real Annual Labor Income | 14763.38 | 16862.28 |
| Owns Home | 0.81 | 0.40 |
| Female | 0.53 | 0.50 |
| Age | 46.56 | 8.75 |
| Birth Year | 1952.8 | 7.20 |
| Birth Month | 6.5 | 3.4 |
|  |  |  |
| Sample Size | 64,225 | |
| *Notes.* We present average sample characteristics for our sample analysis sample. | | |

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| **Table 3** Relationship between Infant Mortality and Later-Life Wellbeing for Those Born Between 1940 and 1964 | | | |
|  | (1) | (2) | (3) |
| Very Good/Excellent Health | -0.0278 | -0.0251 | -0.0243 |
| *(mean = 0.72)* | (0.0191) | (0.0191) | (0.0191) |
|  |  |  |  |
| Poor/Very Poor Health | 0.0368\*\*\* | 0.0374\*\*\* | 0.0369\*\*\* |
| *(mean = 0.10)* | (0.0140) | (0.0139) | (0.0138) |
|  |  |  |  |
| Has Recent IP Visits | 0.0042 | 0.0021 | 0.0019 |
| *(mean = 0.08)* | (0.0077) | (0.0074) | (0.0073) |
|  |  |  |  |
| Has Reported Health Problems | 0.0138 | 0.0107 | 0.0112 |
| *(mean = 0.59)* | (0.0206) | (0.0203) | (0.0201) |
|  |  |  |  |
| Has Arm/Leg/Hand Problem | 0.0403\* | 0.0381\* | 0.0372\* |
| *(mean = 0.27)* | (0.0225) | (0.0224) | (0.0223) |
|  |  |  |  |
| Has Chest/Breathing Problem | 0.0377\*\* | 0.0351\*\* | 0.0347\*\* |
| *(mean = 0.11)* | (0.0157) | (0.0158) | (0.0160) |
|  |  |  |  |
| Has Heart/BP Problem | 0.0150 | 0.0096 | 0.0101 |
| *(mean = 0.13)* | (0.0196) | (0.0195) | (0.0196) |
|  |  |  |  |
| Disabled | 0.0617\*\*\* | 0.0610\*\*\* | 0.0607\*\*\* |
| *(mean = 0.12)* | (0.0142) | (0.0145) | (0.0146) |
|  |  |  |  |
| Has a Job | -0.0806\*\*\* | -0.0647\*\*\* | -0.0642\*\*\* |
| *(mean = 0.71)* | (0.0238) | (0.0221) | (0.0222) |
|  |  |  |  |
| Has Any Annual Labor Income | -0.0839\*\*\* | -0.0685\*\*\* | -0.0680\*\*\* |
| (*mean =0.78)* | (0.0231) | (0.0212) | (0.0213) |
|  |  |  |  |
| Real Annual Labor Income | -2,655.8\*\* | -2032.1\* | -2008.04\* |
| *(mean = 14763.38)* | (1142.4) | (1121.7) | (1114.2) |
|  |  |  |  |
| Owns Home | -0.0006 | -0.0003 | 0.0002 |
| *(mean = 0.81)* | (0.0229) | (0.0229) | (0.0231) |
|  |  |  |  |
| Additional Controls | N | Y | Y |
| Birth Rate | N | N | Y |
| *Notes.* Each estimate comes from a separate regression. The key independent variable, infant mortality, is standardized to be mean 0 and standard deviation 1. All regressions control for region, year, and month of birth. Additional controls include dummies for current age, sex, and current region of residence. In column 3 we add a control for the birth rate which varies by region and cohort of birth. For real annual labor income, we report the marginal effect following estimation using a GLM procedure with a gamma distribution and log link function. The sample size in all regressions is 64,225. Standard errors clustered by region-by-year of birth are in parentheses.  \* p<0.10, \*\* p<0.05, \*\*\* p<0.01 | | | |

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| **Table 4** Placebo Estimates of the Relationship between Infant Mortality and Later-Life Wellbeing for Those Born Between 1940 and 1964 | | | |
|  |  | Placebo p-values | |
|  | Original Estimate and Standard Error | Randomly reassign birth regions | Randomly reassign birth cohorts |
| Very Good/Excellent Health | -0.0243 | 0.125 | 0.307 |
| *(mean = 0.72)* | (0.0191) |  |  |
|  |  |  |  |
| Poor/Very Poor Health | 0.0369\*\*\* | 0.023\*\* | 0.053\* |
| *(mean = 0.10)* | (0.0138) |  |  |
|  |  |  |  |
| Has Recent IP Visits | 0.0019 | 0.852 | 0.822 |
| *(mean = 0.08)* | (0.0073) |  |  |
|  |  |  |  |
| Has Reported Health Problems | 0.0112 | 0.552 | 0.652 |
| *(mean = 0.59)* | (0.0201) |  |  |
|  |  |  |  |
| Has Arm/Leg/Hand Problem | 0.0372\* | 0.175 | 0.226 |
| *(mean = 0.27)* | (0.0223) |  |  |
|  |  |  |  |
| Has Chest/Breathing Problem | 0.0347\*\* | 0.087\* | 0.021\*\* |
| *(mean = 0.11)* | (0.0160) |  |  |
|  |  |  |  |
| Has Heart/BP Problem | 0.0101 | 0.570 | 0.568 |
| *(mean = 0.13)* | (0.0196) |  |  |
|  |  |  |  |
| Disabled | 0.0607\*\*\* | 0.005\*\*\* | 0.000\*\*\* |
| *(mean = 0.12)* | (0.0146) |  |  |
|  |  |  |  |
| Has a Job | -0.0642\*\*\* | 0.041\*\* | 0.017\*\* |
| *(mean = 0.71)* | (0.0222) |  |  |
|  |  |  |  |
| Has Any Annual Labor Income | -0.0680\*\*\* | 0.042\*\* | 0.012\*\* |
| *(mean = 0.78)* | (0.0213) |  |  |
|  |  |  |  |
| Real Annual Labor Income | -2008.04\* | 0.124 | 0.058\* |
| *(mean = 14763.38)* | (1114.2) |  |  |
|  |  |  |  |
| Owns Home | 0.0002 | 0.997 | 0.994 |
| *(mean = 0.81)* | (0.0231) |  |  |
| *Notes.* Each estimate comes from a separate regression. For comparison, Column 1 reports the estimates from Column 3 of Table 3. The key independent variable, infant mortality, is standardized to be mean 0 and standard deviation 1. All regressions control for region, year, and month of birth. Additional controls include dummies for current age, sex, and current region of residence, as well as birth rate which varies by region and cohort of birth. The sample size in all regressions is 64,225. Placebo p-values are computed as c/n where c = # times (|Placebo Estimate| >= |Actual Estimate|) and n = number of replications. In each placebo test, n=1000. 1st randomization: randomly reassigns birth regions, so everyone in the same birth region (across all birth cohorts) is assigned a randomly selected birth region. Observations are assigned the infant mortality in the random region in their birth year. 2nd randomization: randomly reassigns birth cohort, so everyone in the same birth year (across all regions) is assigned a randomly selected birth year. Standard errors clustered by region-by-year of birth are in parentheses.  \* p<0.10, \*\* p<0.05, \*\*\* p<0.01 | | | |

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| **Table 5** Infant Mortality Estimates Based on Different Birth Cohorts | | | | |
|  | (1) | (2) | (3) | (4) |
| Very Good/Excellent Health | -0.0243 | -0.0118 | 0.0222 | -0.0049 |
| *(mean = 0.72)* | (0.0191) | (0.0177) | (0.0359) | (0.0214) |
|  |  |  |  |  |
| Poor/Very Poor Health | 0.0369\*\*\* | 0.0275\*\* | 0.0310 | 0.0231 |
| *(mean = 0.10)* | (0.0138) | (0.0118) | (0.0235) | (0.0146) |
|  |  |  |  |  |
| Has Recent IP Visits | 0.0019 | -0.0055 | 0.0101 | 0.0028 |
| *(mean = 0.08)* | (0.0073) | (0.0066) | (0.0121) | (0.0078) |
|  |  |  |  |  |
| Has Reported Health Problems | 0.0112 | -0.0008 | 0.0010 | 0.0147 |
| *(mean = 0.59)* | (0.0201) | (0.0185) | (0.0318) | (0.0225) |
|  |  |  |  |  |
| Has Arm/Leg/Hand Problem | 0.0372\* | 0.0347\* | -0.0003 | 0.0158 |
| *(mean = 0.27)* | (0.0223) | (0.0195) | (0.0425) | (0.0239) |
|  |  |  |  |  |
| Has Chest/Breathing Problem | 0.0347\*\* | 0.0369\*\* | 0.0407 | 0.0345\* |
| *(mean = 0.11)* | (0.0160) | (0.0149) | (0.0295) | (0.0185) |
|  |  |  |  |  |
| Has Heart/BP Problem | 0.0101 | 0.0029 | 0.0141 | 0.0123 |
| *(mean = 0.13)* | (0.0196) | (0.0181) | (0.0324) | (0.0227) |
|  |  |  |  |  |
| Disabled | 0.0607\*\*\* | 0.0519\*\*\* | 0.0712\*\*\* | 0.0630\*\*\* |
| *(mean = 0.12)* | (0.0146) | (0.0126) | (0.0265) | (0.0158) |
|  |  |  |  |  |
| Has a Job | -0.0642\*\*\* | -0.0567\*\*\* | -0.0664\* | -0.0488\* |
| *(mean = 0.71)* | (0.0222) | (0.0190) | (0.0364) | (0.0251) |
|  |  |  |  |  |
| Has Any Annual Labor Income | -0.0680\*\*\* | -0.0620\*\*\* | -0.0597\* | -0.0533\*\* |
| *(mean = 0.78)* | (0.0213) | (0.0187) | (0.0355) | (0.0238) |
|  |  |  |  |  |
| Real Annual Labor Income | -2008.04\* | -1265.2 | -2758.9\* | -2062.8\* |
| *(mean = 14763.38)* | (1114.2) | (902.8) | (1482.5) | (1239.4) |
|  |  |  |  |  |
| Owns Home | 0.0002 | -0.0087 | -0.0395 | -0.0162 |
| *(mean = 0.81)* | (0.0231) | (0.0205) | (0.0365) | (0.0252) |
|  |  |  |  |  |
| 1940 to 1964 (original estimate) | Y | N | N | N |
| 1936 to 1964 | N | Y | N | N |
| 1940 to 1950 | N | N | Y | N |
| 1940 to 1960 | N | N | N | Y |
| Sample Size | 64,225 | 70,713 | 26,188 | 51,896 |
| *Notes.* Each estimate comes from a separate regression. For comparison, Column 1 reports the estimates from Column 3 of Table 3. The means of each dependent variable correspond to the means in Table 3 for the birth cohorts between 1940 and 1964. The key independent variable, infant mortality, is standardized to be mean 0 and standard deviation 1. All regressions control for region, year, and month of birth. Additional controls include dummies for current age, sex, and current region of residence, as well as birth rate which varies by region and cohort of birth. Standard errors clustered by region-by-year of birth are in parentheses.  \* p<0.10, \*\* p<0.05, \*\*\* p<0.01 | | | | |

|  |  |  |  |
| --- | --- | --- | --- |
| **Table 6** Those Born Between 1940 and 1964 Excluding London Born | | | |
|  | (1) | (2) | (3) |
| Very Good/Excellent Health | -0.0314 | -0.0300 | -0.0230 |
| *(mean = 0.72)* | (0.0204) | (0.0203) | (0.0201) |
|  |  |  |  |
| Poor/Very Poor Health | 0.0388\*\* | 0.0404\*\*\* | 0.0360\*\* |
| *(mean = 0.10)* | (0.0152) | (0.0150) | (0.0147) |
|  |  |  |  |
| Has Recent IP Visits | 0.0021 | 0.0007 | -0.0007 |
| *(mean = 0.08)* | (0.0083) | (0.0078) | (0.0078) |
|  |  |  |  |
| Has Reported Health Problems | 0.0107 | 0.0087 | 0.0094 |
| *(mean = 0.59)* | (0.0215) | (0.0212) | (0.0209) |
|  |  |  |  |
| Has Arm/Leg/Hand Problem | 0.0478\*\* | 0.0460\* | 0.0392\* |
| *(mean = 0.28)* | (0.0235) | (0.0235) | (0.0230) |
|  |  |  |  |
| Has Chest/Breathing Problem | 0.0398\*\* | 0.0376\*\* | 0.0349\* |
| *(mean = 0.11)* | (0.0172) | (0.0174) | (0.0179) |
|  |  |  |  |
| Has Heart/BP Problem | 0.0114 | 0.0047 | 0.0080 |
| *(mean = 0.13)* | (0.0217) | (0.0216) | (0.0218) |
|  |  |  |  |
| Disabled | 0.0653\*\*\* | 0.0641\*\*\* | 0.0627\*\*\* |
| *(mean = 0.12)* | (0.0155) | (0.0159) | (0.0159) |
|  |  |  |  |
| Has a Job | -0.0904\*\*\* | -0.0753\*\*\* | -0.0718\*\*\* |
| *(mean = 0.71)* | (0.0246) | (0.0234) | (0.0238) |
|  |  |  |  |
| Has Any Annual Labor Income | -0.0923\*\*\* | -0.0774\*\*\* | -0.0743\*\*\* |
| *(mean = 0.78)* | (0.0232) | (0.0218) | (0.0223) |
|  |  |  |  |
| Real Annual Labor Income | -2734.8\*\* | -2253.0\* | 2063.2\* |
| *(mean = 14612.09)* | (1202.5) | (1193.7) | (1204.9) |
|  |  |  |  |
| Owns Home | 0.0010 | -0.0006 | -0.0008 |
| *(mean = 0.81)* | (0.0232) | (0.0233) | (0.0235) |
|  |  |  |  |
| Additional Controls | N | Y | Y |
| Birth Rate | N | N | Y |
| *Notes.* Each estimate comes from a separate regression. The key independent variable, infant mortality, is standardized to be mean 0 and standard deviation 1. All regressions control for region, year, and month of birth. Additional controls include dummies for current age, sex, and current region of residence. In column 3 we add a control for the birth rate which varies by region and cohort of birth. The sample size in all regressions is 58,469. Standard errors clustered by region-by-year of birth are in parentheses.  \* p<0.10, \*\* p<0.05, \*\*\* p<0.01 | | | |

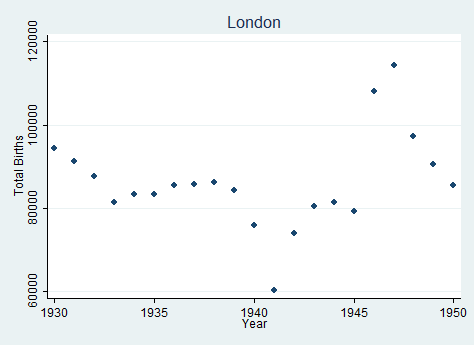
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| --- | --- | --- | --- |
| **Table 7** Relationship between Infant Mortality and Later-Life Wellbeing for Those Born Between 1940 and 1964, with Infant Mortality Set to Zero from 1942-1964 | | | |
|  | (1) | (2) | (3) |
| Very Good/Excellent Health | -0.0041 | -0.0038 | -0.0100 |
| *(mean = 0.72)* | (0.0156) | (0.0157) | (0.0167) |
|  |  |  |  |
| Poor/Very Poor Health | 0.0053 | 0.0074 | 0.0123 |
| *(mean = 0.10)* | (0.0097) | (0.0102) | (0.0112) |
|  |  |  |  |
| Has Recent IP Visits | -0.0005 | -0.0032 | -0.0014 |
| *(mean = 0.08)* | (0.0080) | (0.0066) | (0.0071) |
|  |  |  |  |
| Has Reported Health Problems | 0.0322\* | 0.0285 | 0.0247 |
| *(mean = 0.59)* | (0.0172) | (0.0173) | (0.0173) |
|  |  |  |  |
| Has Arm/Leg/Hand Problem | 0.0023 | 0.0019 | 0.0090 |
| *(mean = 0.27)* | (0.0200) | (0.0194) | (0.0212) |
|  |  |  |  |
| Has Chest/Breathing Problem | 0.0348\*\* | 0.0323\* | 0.0359\*\* |
| *(mean = 0.11)* | (0.0176) | (0.0180) | (0.0181) |
|  |  |  |  |
| Has Heart/BP Problem | 0.0378 | 0.0302 | 0.0265 |
| *(mean = 0.13)* | (0.0235) | (0.0245) | (0.0241) |
|  |  |  |  |
| Disabled | 0.0380\*\*\* | 0.0382\*\*\* | 0.0414\*\*\* |
| *(mean = 0.12)* | (0.0143) | (0.0146) | (0.0152) |
|  |  |  |  |
| Has a Job | -0.0855\*\*\* | -0.0602\*\*\* | -0.0654\*\*\* |
| *(mean = 0.71)* | (0.0234) | (0.0213) | (0.0222) |
|  |  |  |  |
| Has Any Annual Labor Income | -0.0955\*\*\* | -0.0705\*\*\* | -0.0756\*\*\* |
| *(mean = 0.78)* | (0.0229) | (0.0200) | (0.0207) |
|  |  |  |  |
| Real Annual Labor Income | -3198.4\*\* | -2454.8\* | -2844.7\* |
| *(mean = 14763.38)* | (1487.8) | (1457.3) | (1501.0) |
|  |  |  |  |
| Owns Home | -0.0276 | -0.0256 | -0.0302 |
| *(mean = 0.81)* | (0.0263) | (0.0265) | (0.0264) |
|  |  |  |  |
| Additional Controls | N | Y | Y |
| Birth Rate | N | N | Y |
| *Notes.* Each estimate comes from a separate regression. The key independent variable, infant mortality, is standardized to be mean 0 and standard deviation 1. All regressions control for region, year, and month of birth, Additional controls include dummies for current age, sex, and current region of residence. In column 3 we add a control for the birth rate which varies by region and cohort of birth. The sample size in all regressions is 64,225. Standard errors clustered by region-by-year of birth are in parentheses.  \* p<0.10, \*\* p<0.05, \*\*\* p<0.01 | | | |

**Year**

**Appendix Fig. 1** Child Mortality for those Age 1 to 5

*Source:* Authors calculation from On the State of the Public Health During the Six Years of War, pp 17

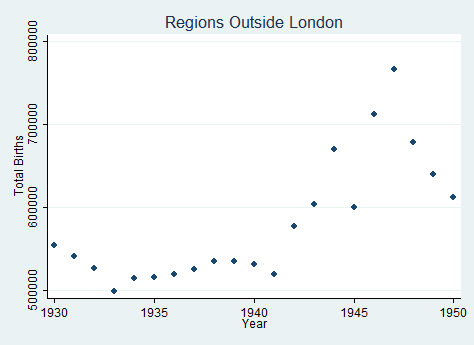
*Notes:*  This figure plots child mortality by age which illustrates that mortality also increased for children age 1 to 5.



**Appendix Fig. 2** Total births recorded in London, 1930-1950

*Source:* Authors calculations from table “mort\_lgd” in the database of “Birth & Death Statistics for Local Government Districts from 1921-1974.”

*Notes:* This figure plots total births in London by year.



**Appendix Fig. 3** Total births outside London, 1930-1950

*Source:* Authors calculations from table “mort\_lgd” in the database of “Birth & Death Statistics for Local Government Districts from 1921-1974.”

*Notes:* This figure plots total births in regions of England outside of London.



**Appendix Fig. 4** Birth Rates, UK, 1935-1950

*Source:* Authors calculations from table “mort\_lgd” in the database of “Birth & Death Statistics for Local Government Districts from 1921-1974.”

*Notes:* This figure plots birth rates in England by year.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Appendix Table 1** Average of January and February’s Maximum and Minimum Temperatures by Region, County, and Year | | | | |
|  | Year | Mean max. temp. (°C) | Mean min. temp. (°C) | Days of frost |
| *North East England (highest infant mortality)* | |  |  |  |
| Durham | 1940 | 2.5 | -2.7 | 21.5 |
|  | 1941 | 3.2 | -2.2 | 16.5 |
|  | 1942 | 2.9 | -2.6 | 23.5 |
|  |  |  |  |  |
| *Yorkshire and the Humber* |  |  |  |  |
| Bradford | 1940 | 2.0 | -3.3 | 21.5 |
|  | 1941 | 3.1 | -1.6 | 18.0 |
|  | 1942 | 2.5 | -2.4 | 24.5 |
|  |  |  |  |  |
| Sheffield | 1940 | 2.7 | -2.2 | 21.0 |
|  | 1941 | 3.6 | -0.5 | 17.5 |
|  | 1942 | 2.9 | -1.6 | 21.5 |
|  |  |  |  |  |
| *West Midlands* |  |  |  |  |
| Valley | 1940 | 6.2 | 1.5 | 10.0 |
|  | 1941 | 6.1 | 1.6 | 6.5 |
|  | 1942 | 6.6 | 0.8 | 9.5 |
|  |  |  |  |  |
| Ross-on-Wye | 1940 | 3.9 | -2.8 | 20.0 |
|  | 1941 | 4.9 | -0.3 | 16.0 |
|  | 1942 | 4.1 | -2.1 | 21.5 |
|  |  |  |  |  |
| *South-East England* |  |  |  |  |
| Oxford | 1940 | 3.8 | -2.2 | 19.5 |
|  | 1941 | 5.2 | 0.1 | 14.0 |
|  | 1942 | 3.2 | -2.3 | 22.5 |
|  |  |  |  |  |
| Manston | 1940 | 3.1 | -0.8 |  |
|  | 1941 |  |  |  |
|  | 1942 | 1.9 | -1.6 |  |
|  |  |  |  |  |
| Southampton | 1940 | 5.1 | -0.5 | 17.0 |
|  | 1941 |  |  |  |
|  | 1942 | 4.5 | -1.5 | 21.0 |
|  |  |  |  |  |
| *East of England* |  |  |  |  |
| Lowestoft | 1940 | 3.1 | -1.7 | 18.5 |
|  | 1941 | 4.2 | -0.6 | 15.5 |
|  | 1942 | 2.3 | -2.0 | 25.0 |
|  | | | | |

|  |  |  |
| --- | --- | --- |
| **Appendix Table 2** Relationship between Infant Mortality and Later-Life Wellbeing for Those Born Between 1940 and 1964 With Region-Specific Linear Time Trends | | |
|  | (1) | (2) |
| Very Good/Excellent Health | -0.0243 | 0.0348 |
| *(mean = 0.72)* | (0.0191) | (0.0313) |
|  |  |  |
| Poor/Very Poor Health | 0.0369\*\*\* | 0.0138 |
| *(mean = 0.10)* | (0.0138) | (0.0208) |
|  |  |  |
| Has Recent IP Visits | 0.0019 | 0.0124 |
| *(mean = 0.09)* | (0.0073) | (0.0117) |
|  |  |  |
| Has Reported Health Problems | 0.0112 | -0.0104 |
| *(mean = 0.59)* | (0.0201) | (0.0310) |
|  |  |  |
| Has Arm/Leg/Hand Problem | 0.0372\* | -0.0227 |
| *(mean = 0.28)* | (0.0223) | (0.0377) |
|  |  |  |
| Has Chest/Breathing Problem | 0.0347\*\* | 0.0326 |
| *(mean = 0.11)* | (0.0160) | (0.0289) |
|  |  |  |
| Has Heart/BP Problem | 0.0101 | 0.0009 |
| *(mean = 0.13)* | (0.0196) | (0.0299) |
|  |  |  |
| Disabled | 0.0607\*\*\* | 0.0655\*\*\* |
| *(mean = 0.12)* | (0.0146) | (0.0222) |
|  |  |  |
| Has a Job | -0.0642\*\*\* | 0.0046 |
| *(mean = 0.71)* | (0.0222) | (0.0336) |
|  |  |  |
| Has Any Annual Labor Income | -0.0680\*\*\* | 0.0004 |
| *(mean = 0.078)* | (0.0213) | (0.0318) |
|  |  |  |
| Real Annual Labor Income | -2008.04\* | -897.2 |
| *(mean = 14763.38)* | (1114.2) | (1538.4) |
|  |  |  |
| Owns Home | 0.0002 | -0.0260 |
| *(mean = 0.81)* | (0.0231) | (0.0380) |
|  |  |  |
| Additional Controls | Y | Y |
| Birth Rate | Y | Y |
| Region-specific time trends | N | Y |
| *Notes.* Each estimate comes from a separate regression. The key independent variable, infant mortality, is standardized to be mean 0 and standard deviation 1. All regressions control for region, year, and month of birth. Additional controls include dummies for current age, sex, current region of residence, and birth rate which varies by region and cohort of birth. Column 1 repeats the estimates from column 3 in Table 3; column 2 adds region-specific linear time trends. The sample size in all regressions is 64,225. Standard errors clustered by region-by-year of birth are in parentheses.  \* p<0.10, \*\* p<0.05, \*\*\* p<0.01 | | |

1. \* Kaestner: University of Illinois at Chicago, IGPA, and NBER; Lo Sasso: University of Illinois at Chicago and IGPA; and Schiman: Georgia Southern University. We thank Marcus Casey, Don Fullerton, Cuiping Schiman, Darren Lubotsky, Ben Ost, Javaeria Qureshi, and seminar participants at UIUC and UIC. [↑](#footnote-ref-1)
2. For example, Brown and Thomas (2013) re-examined the question of whether the 1918 flu pandemic had lasting effects on adult health and reported that there was no association once controls for confounding factors were included in the analysis. [↑](#footnote-ref-2)
3. http://www.metoffice.gov.uk/climate/uk/stationdata/ [↑](#footnote-ref-3)
4. Specifically, we use table “mort\_lgd” which records “Birth & Death Statistics for Local Government Districts from 1921-1974.” [↑](#footnote-ref-4)
5. Approximately 59% of our sample report suffering from one or more of the thirteen conditions. The top three reported conditions include arm/leg problems (27.3%), heart/BP problems (13.1%), and chest or breathing problems (11.4%). [↑](#footnote-ref-5)
6. We adjust annual labor income for inflation using the CPI index available here <https://www.ons.gov.uk/economy/inflationandpriceindices/timeseries/d7bt/mm23> (accessed 21 December 2016). We use 2008 as the base year. [↑](#footnote-ref-6)
7. In a separate specification (available upon request) we also included a survey year linear trend, which had virtually no effect on our estimates. [↑](#footnote-ref-7)
8. However, for those who return to their permanent residence, some of the effect of exposure could be confounded with their moving during childhood. [↑](#footnote-ref-8)
9. We also estimated a non-linear specification where infant mortality entered as a quadratic (available upon request), but the results do not differ qualitatively from the linear specification. [↑](#footnote-ref-9)
10. There are 362,880 possible permutations. [↑](#footnote-ref-10)